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11 Jul 97

From: Director, Office of Naval Research, Seattle Regional Office, 1107 NE 45th St., Suite 350, Seattle, WA 98105
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Subj: RETURNED GRANTEE/CONTRACTOR TECHNICAL REPORTS

1. This confirms our conversations of 27 Feb 97 and 11 Jul 97. Enclosed are a number of technical reports which were returned to our agency for lack of clear distribution availability statement. This confirms that all reports are unclassified and are "APPROVED FOR PUBLIC RELEASE" with no restrictions.

2. Please contact me if you require additional information. My e-mail is *silverr@onr.navy.mil* and my phone is (206) 625-3196.

ROBERT J. SILVERMAN

To: Regional Director
Team Leader
ACO

This technical report was sent to me by DTIC because it does not include the DD-1498 form with the proper disclosure/distribution statement.

Please obtain this form with proper instructions and return it and the technical report directly to DTIC.

Also implement procedures with the contractor to correct this problem.

Thank You,

Jim Carbonara,
Director, Field Operations

FINAL REPORT

Workshop on Optical Properties
of Mesoscopic Semiconductor Structures

ONR Contract No. N00014-93-1-0427

Principal Investigator

P. Craig Taylor
Department of Physics
University of Utah
Salt Lake City UT 84112

Abstract

A Workshop on Optical Properties of Mesoscopic Semiconductor Structures was held at Snowbird, UT on 20-23 April 1993. The workshop attracted approximately 85 attendees with 24 invited speakers and approximately 30 contributed papers. The objective of the workshop was to focus on fundamental electronic and optical processes and device applications of novel semiconducting microstructures, with particular emphasis upon understanding, optimizing and exploiting large optical nonlinearities.

Conference Summary

The Workshop on Optical Properties of Mesoscopic Semiconductor Structures held at Snowbird, UT between April 20 and April 23, 1993 provided a broad-based forum for discussion of new results--both experimental and theoretical--aimed towards understanding the physical basis for fast electronic and optical responses in semiconductors, especially in semiconductor heterostructures, superlattices, quantum wires and dots. The invited and contributed papers discussed the following topics:

- Intrinsic and extrinsic energy transfer processes
- Gain, stimulated emission, and superradiance and their dependences on semiconductor microstructure
- Excitonic screening on fast time scales
- Bulk and interfacial atomic structure
- Conceptual and physical limitations for devices and device structures
- Electronic dephasing processes in bulk and in microstructures
- Fast carrier and excitonic cooling and carrier-carrier scattering
- Phenomena leading to high-speed generation, response and switching
- Electronic and optical properties of excitons and exciton-polaritons in bulk and quantum structures
- Optical measurement in highly polarizable excitonic systems
- Dielectric response of semiconducting structures
- Impurity-related optical nonlinearities
- Spatial localization and band dispersion under superlattice formation
- Electronic structure of semiconducting structures

The goal of the conference was to provide a platform for a unified, cross-disciplinary approach to optical processes in semiconductor nanostructures that emphasized atomic-scale dimensions and interactions. Researchers were brought together from diverse fields--those who have traditionally not met in the past--for the express purpose of discussing optical properties. The announcement of the meeting is enclosed as Appendix A. A copy of the program for the Workshop is enclosed as Appendix B. There were no proceedings published as a result of this Workshop.

Appendix A

Second Workshop on

Optical Properties of Mesoscopic Semiconductor Structures

Snowbird, Utah
20-23 April 1993

The objective of this workshop is to focus on fundamental electronic and optical processes and device applications of novel semiconducting microstructures, with particular emphasis upon understanding, optimizing and exploiting large optical nonlinearities. To this end, we wish to provide a broad-based forum for presentation and discussion of new results--both experimental and theoretical--aimed towards a detailed understanding of the physical basis for fast electronic and optical response in the semiconductor bulk, and especially in semiconductor homostructures, heterostructures, superlattices, quantum wires, and quantum dots.

Such microstructure work has traditionally evolved as a natural outgrowth of "band-gap engineering" of semiconducting materials and structures. Herein, electronic and optical properties have, as a rule, been adjusted and tuned by material band structure, through systematic variation of *macroscopic* quantities such as material composition, doping and layer thickness--and as such, their consequences have generally been appreciated and adequately explained in continuum terms and concepts, and from bulk-materials properties. In contrast to this quite successful, semi-classical approach to electronic and optical response, it is becoming, however, ever more clear that future progress toward fully appreciating the limitations on magnitude, speed and optimal utilization of nonlinear optical responses in new semiconducting systems and structure, should rely upon a blend of *both* macroscopic semi-classical considerations, and detailed microscopic atomic and quantum mechanical considerations. Indeed, optical nonlinearities are, by definition, a microscopic effect, arising from multiple excitations of the electronic system and possibly from momentum mixing from throughout k-space.

Thus, the ultimate goal of full understanding and use of the interaction between light and electronic excitations to induce highly nonlinear optical responses can only result from a unified, cross-disciplinary approach emphasizing atomic-scale dimensions and interactions. In this workshop, we will bring together researchers from diverse fields--those who may not have traditionally met in the past, for the express purpose of discussing optical nonlinearities. In particular, these may include researchers not just currently devoted to, and expert in, nonlinear optics, but also, for example those in semiconductor preparation; in atomic microscopy and interfacial characterization; in spectroscopic measurements of optical excitations and carrier recombination (both radiative and nonradiative); in measurement and production of electronic excitations on a fast time scale; in quantum coherence effects and coherent energy transfer; in small-structure fabrication and device modeling; in field-perturbative effects in semiconducting materials; in carrier trapping and recombination, and elementary excitations at semiconductor defects; and in detailed quantum-mechanical modeling of excitation wavefunctions (in both real-space and k-space), oscillator strengths and lifetimes, transient screening, and time-dependent dielectric response of materials. We therefore intend to provide a platform for open and wide-ranging discussion of all major aspects of optoelectronic research.

Organizers

S.G. Bishop (Illinois)
L.R. Cooper (ONR)
H.M. Gibbs (Arizona)
M. Jaros (Newcastle)
P.C. Taylor (Utah)
D.J. Wolford (IBM)

Appendix B

Second Workshop

on

OPTICAL PROPERTIES OF
MESOSCOPIC SEMICONDUCTOR
STRUCTURES

Snowbird, Utah

20-23 April 1993

Program for the Workshop on

OPTICAL PROPERTIES OF MESOSCOPIC
SEMICONDUCTOR STRUCTURES

20-23 April 1993
Snowbird, Utah

MONDAY, 19 APRIL

6:00 p.m.	Registration
8:00 p.m.	Reception - Golden Cliff

TUESDAY, 20 APRIL

Chair:	**DonWolford**
8:00 a.m.	E.I. Rashba, University of Utah, "*Spectroscopy of Strongly Interacting Confined Electrons*"
9:00 a.m.	R.G. Ulbrich, Georg-August University Goettingen, "*Excitons and Polaritons in Nanostructure Environments* "
10:00 a.m.	BREAK
10:30 a.m.	C.L. Andreani, University of Pavia, "*Exciton-Polaritons in Confined Systems: From Bulk to Quantum Wells*"
11:30 a.m.	Panel Discussion on "Si/SiGe Strained Layer Superlattices"

- **Milan Jaros (Chair)**, University of Newcastle Upon Tyne
- David Robbins, Royal Signals and Radar Establishment

12:30 p.m. LUNCH (on your own)

Chair: J. Merz

2:00 p.m. H. Kukimoto, Tokyo Institute of Technology, "*AlP/GaP Short-Period Superlattices*"

3:00 p.m. T. Fukui, Hokkaido Univeristy, "*The Fabrication and Electrical and Optical Properties of Quantum Wires and Dots*"

4:00 p.m. BREAK

Chair: H. Haug

4:30 p.m. D. Heitmann, University of Hamburg, "*FIR Spectroscopy of Quantum-Dot Atoms*"

5:30 p.m. S.F. Alvarado, IBM Research Division, Zurich, "*Optical Spectroscopy of Single Quantum Structures with Nanometer Resolution*"

6:30 p.m. DINNER (on your own)

8:00 p.m. Late Session

M. Dutta, U.S. Army Research Laboratory, "*Polarization Rotation and its Dynamics in Uniaxially Strained GaAs/AlGaAs Multiple Quantum Wells*"

H.P. Hjalmarson, Sandia National Laboratories, "*Spatial Expansion of the H-Band*"

W.H. Knox, AT&T Bell Labs, "*Virtual Excitations of the Fermi-Edge Singularity*"

H. Haug, J.W. Goethe University, "*Electro- and Magneto-Optical Properties of Quantum Wires*"

S.G. Bishop, University of Illinois at Urbana-Champaign, "*Optical Characterization of InGaAs/InP Quantum Wires*"

C.J. Stanton, University of Florida, "*Electronic, Transport and Optical Properties of 1-D Quantum Wires: Applications to Porous Silicon*"

Chair: A. Smirl

S. Das Sarma, University of Maryland, "*Theory of Photoluminescence from Two-Dimensional Wigner Crystals*"

R.G. Ulbrich, Georg-August Universitaet Goettingen, "*Tunnel Current Induced Luminescence from Gold-Passivated Gallium Arsenide*"

O.J. Glembocki, Naval Research Laboratory, "*Optical and Modulated Optical Properties of Ordered Alloys*"

M.C. DeLong, University of Utah, "*Effect of Domain Size on Disordering in* $Ga_{0.52}In_{0.48}P$"

R.M. Cohen, University of Utah, "*Material Stability Considerations for Mesoscopic Structures Based on the GaInAsP System*"

K.K. Bajaj, Emory University, "*A Quantum Statistical Theory of Excitonic Linewidth Due to Compositional Disordering in Semiconductor Alloys and Quantum Well Structures*"

J.S. Harris, Jr., Stanford University, "*Three-Step, Asymmetric Quantum Wells for High Performance Optical Applications*"

A. Yariv, California Institute of Technology, "*Bandgap Tailoring of Optical Properties of Quantum Well Lasers*"

J.G. Fujimoto, Massachusetts Institute of Technology, "*Femtosecond Carrier Dynamics in InGaAs/AlGaAs Strained-Layer Single-Well Diode Lasers*"

H.M van Driel, University of Toronto and Ontario Laser and Lightwave Research Center, "*Control of Photocurrent Directionality in Quantum Structures by Laser Coherence*"

6:30 p.m. DINNER (on your own)

8:30 p.m. Poster Session

WEDNESDAY, 21 APRIL

Chair: S. Bishop

8:00 a.m. C. Weisbuch, Thomson CSF, "*Sharp Optical Features in Interband Transitions in Solids: Electron vs. Photon Confinement*"

9:00 a.m. L.E. Brus, AT&T Bell Labs, "*Luminescence of Direct and Indirect Gap Quantum Semiconductor Crystallites*"

10:00 a.m. BREAK

Chair: P.C. Taylor

10:30 a.m. R. Bhargava, Philips Laboratories, "*Doped Nanocrystals of Semiconductors--A New Class of Materials*"

11:30 a.m. Alexander Efros, Technical University München, "*Optical Spectroscopy of Quantum Size Levels in Nanometer-Size Crystals*"

12:30 LUNCH (on your own)

4:30 p.m. Contributed Papers

Chair: T. Kennedy

A.L. Smirl, University of Iowa, "*Nonlinearities and Enhanced Transport Associated with Charge Separation and Screening in Strained and Doped Quantum Well Structures*"

P.M. Fauchet, University of Rochester, "*Nonlinear Optics in Ultranarrow p-Type GaAs Quantum Wells*"

D. Wake, University of Illinois, "*Picosecond Imaging of Excitonic Molecules in GaAs/AlGaAs Quantum Wells--Transient Behavior and Effect on Lateral Transport*"

J. Merz, University of California at Santa Barbara, "*Effects of Exciton Tunneling on a Near-Surface Quantum Well*"

J. Khurgin, The Johns Hopkins University, "*Comparative Analysis of the Intersubband vs. Band-to-Band Absorption in the Quantum Wells*"

N. Tolk, Vanderbilt University, "*Free-Electron Laser Internal Photoemission Measurements: Electronic Properties of Nano- and Meso-Structures* "

M.A. Stroscio, U.S. Army Research Office, "*Confined and Interface Optical Phonons in Quantum Wells and Quantum Wires*"

T.L. Reinecke, Naval Research Laboratory, "*Phonons and Electron-Phonon Interactions in Mesoscopic Semiconductor Structures*"

E.E. Haller, University of California at Berkeley and Lawrence Berkeley Lab, "*Semiconductor Isotope Engineering*"

Chair: M. Stroscio

J. Olajos, University of Lund, "*Electrical and Optical Properties of Short-Period Si_mGe_n Superlattices*"

T.A. Kennedy, Naval Research Laboratory, "*Recombination Processes in $Si/Si_{1-x}Ge_x$ Heterostructures*"

THURSDAY, 22 APRIL

Chair: S. Das Sarma

8:00 a.m. L.J. Sham, University of California at San Diego, "*The Role of Exchange and Correlation in Time-Resolved Optical Spectroscopy*"

9:00 a.m. D.G. Steel, University of Michigan, "*Coherences and Dynamics of Resonances in Semiconductor Heterostructures*"

10:00 a.m. BREAK

Chair: P. Fauchet

10:30 a.m. D.S. Kim, AT&T Bell Labs, "*Time Evolution of Femtosecond Coherent Signals: Time, Not Just Time Delay*"

11:30 p.m. E.W. Van Stryland, University of Central Florida, "*Scaling Laws for Nonlinear Absorption and Refraction in Bulk Semiconductors*"

12:30 p.m. LUNCH

Chair: H. Gibbs

2:00 p.m. J.B. Stark, AT&T Bell Labs, "*Energy Relaxation in Two- and Zero-Dimensional Semiconductors*"

3:00 a.m. R. Binder, University of Arizona, "*Optical Nonlinearities in Quantum Confined Semiconductors*"

4:00 p.m. BREAK

Chair: L. Cooper

4:30 p.m. F. Capasso, AT&T Bell Labs, "*New Coupled Quantum Well Structures with Giant*

Nonlinear Optical Properties and Bound States in the Continuum"

5:30 p.m. K. Hess, University of Illinois, "*Numerical Simulation of Quantum Well Heterostructure Lasers*"

8:00 p.m. BANQUET

FRIDAY, 23 APRIL

Chair: R. Bhargava

8:00 a.m. A. Nurmikko, Brown University, "*The New Blue Horizon: Quantum Well Lasers and Lower Dimensional Physics in II-VI Semiconductor Heterostructures*"

9:00 a.m. K.J. Vahala, California Institute of Technology, "*Towards Lower-Dimensional Quantum Structure Fabrication by Selective Growth and Gas Phase Nucleation*"

10:00 a.m. BREAK

Chair: J.S. Harris

10:30 a.m. D. Deppe, University of Texas at Austin, "*Electrodynamics in Semiconductor Microcavities and Microcavity Lasers*"